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An Eclectic Causality Model for Income Growth: Evidence from Greece

by
Athanasios L. Athanasenas[1], Constantinos Katrakilidis[**2]

Abstract:

We present time series evidence theoretically consistent with the New Keynesian view for income growth, using Greek annual data over the period 1970-2004. The empirical analysis employs a hybrid model for income growth using the ARDL approach to co integration. Evidently, growth financing, under changing fiscal and monetary regimes and interest rates' management are inextricably linked. These links still remain challenging and further research needs.

Keywords: *Interest Rates and Income, Export-Led Growth, Co integration, ARDL*

JEL Classification: E44, C22, O47

1. Introduction

It is beyond any scientific dispute that arriving at a well-informed view on the magnitude and dynamics of the effects of monetary and real economic variables on GDP growth is indeed very complicated. Besides, another economic issue still under debate is whether fluctuations in money (however defined) could affect fluctuations in income (nominal or real) and prices over time, in a regular and systematic way. Pending upon the adopted monetary policy process through specific monetary instruments, different empirical testing procedures accrue.

Indeed, if money, as the central bank's basic policy instrument, bears no implication for contemporaneous and/or subsequent movements in aggregate income or prices, then money (in general terms) has no role to play within the aggregate growth process, this being for both the short and long run. However, conflicting evidence on the role of money and/or interest rates on income is reported in the relevant international empirical literature (Sims, 1972; 1980; Bernanke and Blinder, 1988; Friedman and Kuttner, 1992; King and Levine, 1993). In this paper, we study the link(s) between interest rates, as the fundamental monetary variable here, government investments and aggregate exports, as the basic real variables, for GDP growth determination, with reference to the Greek Economy; given the currently existing and available yearly data from 1970 up to 2004 (applying the last I.F.S. (I.M.F.) and O.E.C.D. data). The main purpose of the paper is to provide new and additional evidence on the role of certain monetary and real variables within the income growth process, thus allowing for a contemporaneous estimation of the

[11] *Department of Business Administration, School of Administration & Economics, Institute of Technology and Education of Serres (A.T.E.I.S.), Terma Magnesias Str. 621-24, Serres, Greece. Tel: +302321049261. Fax: +302321049165. Corresponding Address: Email: athans@teiser.gr.*
[2] *Department of Economics, Aristotle University of Thessalonik, P.O. Box 213, Thessaloniki 54006, Greece.Email: katrak@econ.auth.gr*

magnitude of the effects of interest rates on income. The export-led growth hypothesis (ELGH) is also considered within this context.

Our research contribution is threefold. First, our hybrid modeling approach takes into account the important missing variables issue. Second, the ARDL approach to cointegration is applied, considering the small samples advantages of the method and the stringent official long-run time series data availability problem of the Greek Economy. Third and final, we provide new evidence with respect to the Greek Economy.

This paper is organized in five sections. Specifically, section I refers to some fundamental views on money and interest rates especially, as they both relate to income growth literature. Section II is a brief note on the recent history of the Greek Economy. Next, section III describes our methodology and the simple model structure that we follow. Section IV clarifies our empirical results, whereas, last section V presents a summary and the main conclusions of the paper. Our appendix, at the end, reports in table form, all our findings.

2. Money, Interest Rates and Income Growth in Perspective

Since the early work of C. A. Sims (1972) empirical validation of money and income luctuations has been established (Sims, 1972; 1980). Given that monetary aggregates' definitions change through time and new monetary policy procedures are introduced by the Federal Reserve in U.S., Friedman and Kuttner (1992) show that the U.S. experience does not provide any strong long run causal relationship between money and non-financial economic activity, for the whole time period under investigation. In contrast, they report significant effects from interest rates on income after 1980. Thus, they conclude that as long as monetary variables no longer contain evidenced information about the non-financial economic variables up to the early 1990's, new sources of potential information must be sought.

On the other hand, it is well known that financial indicators, such as the importance of the banks relative to the central bank, the percentage of credit allocate to private firms and the ratio of credit issued to private firms to GDP, are strongly related with growth (King and Levine (1993)).

Murdock and Stiglitz (1993) argue that by lowering the cost of borrowing, government increases the profitability of firms and thus their investment. As a result of lower interest rates, banks will attract safer applicants for loans, thus lowering the probability of default and enhancing the safety of banks. Consequently, the greater safety by banks and a more efficient and productive financial system may induce more savings towards investment (Murdock and Stiglitz (1993))[3]. Further evidence reveals that the exogenous components of financial intermediary development are positively associated with economic growth (Levine *et al.,* 2000)[4].

In the process of economic growth, governments, intending to transfer economic revenues towards public investments, finance public activities by expanding money supply above real money balances, thus inducing inflation. Inflation, next, is a mechanism of transferring resources to the government through seigniorage. Bruno

[3] See for additional details, Angeloni *et al.* (2003).

[4] For the relevant role of the monetary process and the financial sector, see, in particular, Stock and Watson , 1989; Feldstein and Stock, 1994; Friedman and Kuttner, 1992; Bernanke and Blinder, 1992; Swanson, 1998).

(1995) showed that for a sample of 127 countries over the 1960-1992 period, inflation rates up to 5 per cent relate positively to growth; whereas, inflation rates above 30 per cent induce negative economic growth relationships. Feldstein (1997), also argues that inflation can have negative effect on capital accumulation, because of the way accumulation depending on what happens to the other factors of production, such as human capital and knowledge. Financing the accumulation of human capital, technology and knowledge relies on reductions in (real) interest rates. Friedman and Kuttner (1992) argue also that market interest rates contain statistically significant information about future fluctuations in income. In addition, Aron and Muellbauer (2001) provide evidence for South Africa that the interest rate transmission effect to output is significant, so that high real interest rates had significantly constrained growth in output, in the 1990s.

With detailed references on the Channels of Monetary Policy – Price Channels and, the Interest Rate Channel in particular, several empirical studies of the Greek Economy reveal the statistically significant influence of short-term (nominal) interest rate shocks on GDP growth (Brissimis, *et al.,* (2001)). Monetary policy took the burden of controlling disinflation during 1995-2000, whereas both fiscal and incomes policies were tightened for overall economic policy sustainability and credibility purposes. Inflation fell from about 9 percent in 1995 to under 3 per cent in 2000, while real income growth averaged more than 3 per cent annually during the last years. As inflation subsided, along with seigniorage, nominal interest rates fell significantly, converging towards E.U. member states with low inflation rates (Garganas and Tavlas, 2001).

A recent strong debate upon the money (M1) – income causality direction has been presented by Karfakis (2002, 2004) and Ozmen (2003), where the ending point seems to be the importance of lag length specification of the estimated VARs, in order to reach a final clue regarding money exogeneity (or, endogeneity) in Greece. In conclusion, what seems to be the key empirical issue is that the results previously gained with respect to the monetary transmission mechanism in the Greek Economy, depend crucially upon the specification of the applied model[5]. Our aim, then, is to use the value of the short-term nominal interest rate as a measure of the ability of the banking system to induce income growth[6],[7].

A last, but not least, reference on the export-led growth hypothesis (ELGH) is necessary to clarify the theoretical perspective in this paper. The export-led growth hypothesis postulates that export expansion is a major determinant of income growth. Exports expansion can perform as an "engine-of-growth". Despite the vast amount of research concerning the ELGH during the past thirty years, the evidence available is far from conclusive and this situation explains some of the reasons as to why the debate on ELGH real economic effects still exists in the economic literature[8].

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[5] See, in particular, Smets and Klein (2001) in R. C. Bryant, N. C. Garganas and G. S. Tavlas (2001); Athanasenas and Papanastasiou (2007).

[6] We use the nominal interest rate in order to capture all possible nominal variation. We also incorporate inflation rate (CPI) as a proxy for monetary policy performance, due to serious lack of available yearly time series data on monetary variables. We add the value of exports (and government investments, also) as a measure for export-led income growth (ELGH).

[7] Nevertheless, the appropriate, all necessary and quality data problem in conducting suitable models and developing econometric analyses of the Greek Economy constitutes a very big order.

[8] The relevant works of Edwards (1998), Barro and Sala-I-Martin (1998), Frankel and Romer (1999), are all excellent sources. As part of an export-led strategy, by the mid-1980s especially the economic literature concerning development economics placed great emphasis on the export promotion policies for policy makers in Developing Countries, in order to induce income growth and economic adjustment. Nevertheless, in only a few cases have the empirical results confirmed that export expansion was indeed substantial to income growth (Kugler, 1991; Afxentiou and Serletis, 1991;

3. A Brief Note on the recent Greek Economy

Greece (Hellenic Republic) is a small open EU economy, with a much less mature financial market compared to other advanced EU economies (i.e.: Germany, France, U.K., etc) or, U.S.A. worldwide. The fairly remarkable growth rates, these being above 3 percent annually, achieved by the Greek Economy after the early nineties have enabled the country to enter the euro zone by 2001 (Appendix III, figure 1).

Until the early 1980's, the Greek Banking system was functioning under a complex system of tight credit rules, within a financial environment of administrative fixed interest rates (Lenive and Zervos (1996, 1998)). Throughout the 80's, a process of gradual market liberalization was motivated by certain economic needs for participation in the single European Market. During the early 1990's (1991-1992), recent modernization of the capital market included the operation of the credit institutions (Basic Banking Law), the operation of the Parallel Stock Exchange for smaller firms, and the Central Securities Depository Company was established. Also, the number of credit institutions increased from 41 to 50, and the role of the Athens Stock Exchange (ASE) was upgraded substantially. Ever since, interest rates are freely determined (figure 2), the public sector meets its borrowing requirements through the money and capital markets, and the banks are allowed to extend credit on competitive terms. Consequently, the major deregulation of the banking sector in 1992 is considered a major breakpoint in the history of the sector itself (See also, Garganas and Tavlas, 2001).

In December 1997, the Greek Parliament approved Central Bank independence. Price stability became the Bank's main goal, along with control over the exchange rate policy within a framework agreed with the government. During this period of the late 1990's, the basic policy innovations were the development of a hard exchange rate policy, commencing in 1995; and, a prohibition of monetary financing of the deficit. The hard exchange rate policy worked to squeeze inflation under 3 percent by 1999 (figure 3), and the prohibition of the monetary financing of the deficit eventually reduced the fiscal deficit itself[9].

4. Methodology and Model Structure

The autoregressive distributed lag (ARDL) approach to cointegration applied in this paper is a relatively new technique for detecting possible long-run relationships among economic variables. The ARDL approach is a more efficient technique for determining cointegrating relationships in small samples. An additional advantage of the ARDL approach is that it can be applied irrespective of the regressors' order of integration (Pesaran and Shin (1999)); that is, it can be applied regardless of the stationary properties of the variables in the sample, thus allowing for statistical inferences on long-run estimates which are not possible under alternative cointegration techniques. Hence, we are not concerned whether the applied series are *I(0) or I(1).* The general form of the ARDL model (Pesaran and Shin, 1999) is defined as:

Henriques and Sadorsky, 1996).

[9] Figures (3) and (4) refer to government investments' and the country's exports' growth rates, accordingly.

$$\Phi(L)\,y_t = \alpha_0 + \alpha_1 w_t + \beta'(L)\,x_{it} + u_t\,, \tag{1}$$

where: $\Phi(L) = 1 - \sum_{i=1}^{\infty} \Phi_t L^i$, and $\beta(L) = \sum_{j=1}^{\infty} \beta_j L^j$,

with *(L)* being the lag operator and (w_t) being the vector of deterministic variables such as the intercept, seasonal dummies, time trends or any exogenous variables (with fixed lags). This approach follows three steps; namely, step one is the establishment of the long-run relationship between the variables (unrestricted error correction mechanism regression). Step two is the estimation of the ARDL form of equation (1), where the optimal lag length is chosen according to the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC). Step three refers to the estimation of error correction equation, using the differences of the variables and the lagged long-run solution, where the speed of adjustment of the equilibrium is determined.

5. Data and Empirical Results

Our empirical analysis engages annual data of the Greek economy taken from the IFS database and the period covered runs from 1972 to 2004. The key determinants of income growth (DLY), which is proxied by the difference of the log of the nominal income (LY), have been considered by including as regressors the nominal expected short-run interest rate (EXIR)[10], the log of the nominal government investment (LIG), the log of the nominal exports (LXP) and the log of the consumer's price index (LP) as a proxy for monetary policy performance. The above variables have been included aiming to capture both *New-Keynesian and Export-led* growth characteristics of the Greek Economy.

In the first step of the empirical analysis we examine the integration properties of the variables involved by means of the conventional Augmented Dickey-Fuller (ADF) test. It should be noted that statistical inference with non-stationary data may lead to invalid results. The results suggest that all variables are non-stationary when tested in log-level form (Table 1), regardless of the existence of an intercept or both an intercept and a linear trend, in the testing equation. Furthermore, when the variables are considered in first difference form (Table 2), all of them exhibit stationary properties. Next, we proceed with the examination of the joint integration properties of the series using the cointegration methodology.

However, the conventional unit-root tests are of low power and in cases of small data samples their evidence should be considered with caution. Thus, instead of employing the traditional methodology proposed by Johansen (1988 and 1989), which requires non-stationary variables of integration order I(1), we apply the ARDL cointegration method proposed by Pesaran (1992). Actually, the ARDL method has the advantage to avoid the problem of pre-testing for the order of integration of the individual series; besides, ARDL is a singe equation estimation technique and requires the estimation of a fairly smaller number of parameters compared to the Johansen's method. Consequently, ARDL proves to be more efficient when small data samples are available.

In the next step, we estimate the unrestricted error correction (EC) model (2), with DLY as the dependent variable and apply an F-test on the group of the lagged level variables. Model (2) is described as follows:

[10] An ARIMA (1,1) process has been applied.

$$DLY_{NOMINAL(N)} = a_0 + \sum_{j=1}^{n} b_j DLY_{t-j} + \sum_{j=0}^{n} c_j DEXIR_{(N)} + \sum_{j=0}^{n} d_j DLIG_{(N)} + \sum_{j=0}^{n} e_j DLXP_{(N)}$$
$$+ \sum_{j=0}^{n} f_j DLP + \lambda_1 LY_{t-1} + \lambda_2 LEXIR_{t-1} + \lambda_3 LIG_{t-1} + \lambda_4 LXP_{t-1} + \lambda_5 LP + \varepsilon_{1t,} \qquad (2)$$

where, the parameter $\lambda_i, (i = 1,2,3,4,5),$ is the corresponding long-run multiplier, while the parameters $b_j, c_j, d_j, e_j, f_j,$ are the short-run dynamic coefficients of the underlying ARDL model.

The optimal lag structure of the model is chosen based on the Schwartz Bayesian Criterion (SBC), using a max lag length of three periods. The F-test along with the critical value bounds are reported in Table (3). The evidence is in favor of the existence of a long-run equilibrium relationship with long-run causality running from LXP, LIG, LP and EXIR towards LY.

Having confirmed the existence of cointegration among the involved variables, we proceed with the estimation of the appropriate ARDL model for the LY variable. The optimal ARDL (3, 0, 0, 1, 0) specification has been chosen based on the SBC and is presented in Table (4). The corresponding diagnostic tests validate the estimates while the plots of the corresponding CUSUM and CUSUMSQ tests, based on the recursive residuals (Graphs 1 and 2), identify long-run structural stability for the model's coefficients.

The estimated long-run coefficients from the implied ARDL structure are reported in Table (5). The estimates reveal strong causal effects (at a smaller than the 1% level of statistical significance) directed from the government investment and the expected interest rates towards income. However, exports and the price level bear no significant impacts on income, in the long-run time horizon. Finally, Table (4), presents the estimates from the EC specification. The existence of a long-run causal relationship among the examined variables is confirmed once again since the coefficient of the lagged EC term is found statistically significant (the p-value of the applied t-test is smaller than the 1%) and has the correct sign suggesting that any deviation from the long-term income path is corrected by 53 percent over the following year. With regard to the short-run dynamics of the estimated relationship, there is evidence of significant Granger-type causal effects running from government investment to income growth (the p-value of the applied t-test is smaller than the 1%). Besides, there is evidence of weaker Granger-causal effects running from the expected interest rate (p-value=0.06) and the inflation rate (p-value=0.09) to income growth.

6. Summary and Conclusions

Summarizing our work, we restate that using annual data over the 1970-2004 period of the Greek economy, our analysis employs an eclectic (hybrid) model for explaining impacts to income growth using the ARDL approach to cointegration.

We further note our emphasis on the macroeconomic role of interest rates mainly, government investments secondly and aggregate exports thirdly, for explaining long-run income growth in the Greek economy over the last three decades.

We follow the New Keynesian theme along with the export-led growth hypothesis (ELGH), as our theoretical foundation.

The empirical findings presented in this paper clearly show that evidence based on the most official and recent Greek economic data does indicate a close and reliable relationship between government investments and income growth, in the long run. The study finds that the ELGH is invalid in the particular case of the Greek Economy.

Moreover, our observable and verifiable empirical relationships bear certain implications for the design and implementation of banking policy on interest rates management. In the presence of evidence indicating that interest rates and income are cointegrated and negatively related, there is sound empirical ground on which to base focused research on the detailed functioning of the interest rate policy and the spread between central and private banking interest rates. On the extent to which fiscal and monetary regimes are important for national growth, interest rates' levels and growth in output remain inextricably linked. On the basis of the selected variables in our model, and our findings that reveal strong causal effects (at a smaller than the 1% level of statistical significance) directed from the government investment and the expected interest rates towards income in the long-run, it is reasonable to conclude that prudent interest rate management, given Central Banks' independence within the European Union, becomes a significant policy implication which verifies our New-Keynesian theoretical foundation.

References

1) Angeloni, I., Kashyap, K. A., Mojon, B. (2003). *Monetary Policy Transmission in the Euro Area.* New York, N.Y.: Cambridge University Press, part 4, chap. 24.
2) Aron, J., Muellbauer, J. (2001). "Interest Rate effects on output: evidence from a GDP forecasting model for S. Africa". *2nd Annual Research Conference I.M.F.,* 29-30th November.
3) Athanasenas, L. A., and Papanastasiou, J. (2007). "Money and Credit: The Case of the Greek Economy in the last two Decades", *Multinational Finance Society (Rutgers University), 14th International Conference,* 1-4 July, 2007, Thessaloniki, Greece.
4) Barro, J. R. and Sala-i-Martin, X. (2004). *Economic Growth,* 2nd Ed., The MIT Press, Cambridge, Mass.
5) Bernanke, S. B. and Blinder, S. A. (1988). "Credit, Money, and Aggregate Demand". *The American Economic Review (Papers and Proceedings),* 78(2), 435-439.
6) Bernanke, S. B. and Blinder, S. A. (1992). "The Federal Funds Rate and the Channels of Monetary Transmission". *The American Economic Review,* 82(4), 901-921.
7) Bernanke, S. B. and Gertler, M. (1995). "Inside the Black Box: The Credit Channel of Monetary Policy Transmission". *The Journal of Economic Perspectives,* 9(4), 27-48.
8) Brissimis, N. S., Magginas, S. N., Simigiannis, T. G. and Tavlas, S. G. (2001). "Issues in the Transmission of Monetary Policy", In R. C. Bryant, N. C. Garganas and G. S. Tavlas (Eds.): *Greece's Economic Performance and*

Prospects, Athens, Greece: The Bank of Greece and The Brookings Institution, Washington, D. C.
9) Bruno, M., (1995). "Does inflation really lower growth?" *Finance and Development,* September issue.
10) Edwards, S., (1998). "Openness, Productivity and Growth: What do we really know?" *Economic Journal,* 108, 2, 383-389.
11) Estrella, A., and Mishkin, F. S., (1997), "Is there a role for monetary aggregates in the conduct of monetary policy?" *Journal of Monetary Economics,* 40, 279-304.
12) Feldstein, M., and Stock, J. (1994). "The use of a monetary aggregate to target nominal GDP", in G. Mankiw (Ed.) *Monetary Policy.* Chicago, University Of Chicago Press.
13) Feldstein, M. (1997). "The Costs and Benefits of going from low inflation to price stability" in *Reducing Inflation: Motivation and Strategy.* C. D. and D. H. Romer (Eds). NBER Studies in Business Cycles, vol. 30, University Of Chicago Press, 123-56.
14) Frankel, M., and Romer, D., (1999). "Does Trade cause Growth? *American Economic Review,* 89, 3, 379-399.
15) Friedman, B. M., and Kuttner, K. N. (1992). "Money, income, prices and interest rates" *American Economic Review,* 82, 472-492.
16) Garganas, C. N. and Tavlas, S. G. (2001). "Monetary Regimes and Inflation Performance: The Case of Greece". In R. C. Bryant *et al. Greece's Economic Performance and Prospects (ibid).*
17) Karfakis, C. (2002). "Testing the quantity theory of money in Greece". *Applied Economics,* 34, 583-587.
18) Karfakis, C. (2004). "Testing the quantity theory of money in Greece: Reply to Ozmen". *Applied Economic Letters,* 11, 541-543.
19) King, G., R., and Levine, R. (1993). "Finance, Entrepreneurship and Growth: Theory and Evidence". *Journal of Monetary Economics,* vol. 32, 1-30.
20) Levine, R., and Zervos, S. (1996). "Stock Market Development and Long-Run Growth". *The World Bank Economic Review,* 10, 323-339.
21) Levine, R., and Zervos, S. (1998). "Stock Markets, Banks and Economic Growth". *American Economic Review,* 88, 537-558.
22) Levine, R., *et al.,* (2000). "Financial Intermediation and Growth: Causality and Causes". *Journal of Monetary Economics,* 46, 31-77.
23) Murdock, K., and Stiglitz, J. (1993). "The Effects of Financial Repression in an Economy with Positive Real Rates". *East Asian Miracle, World Bank.*
24) Ozmen, E., (2003). "Testing the quantity theory of money in Greece". *Applied Economic Letters,* 10, 971-074.
25) Pesaran, H., Shin, Y. (1999). "An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis". In S. Strom (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium.* Cambridge University Press, Cambridge.
26) Sims, C. A., (1972). "Money, Income, and Causality". *American Economic Review,* vol. 62, 540-552.
27) Sims, C. A., (1980). "Comparison of Interwar and Post-war Business Cycles". *American Economic Review,* vol. 70, 250-277.
28) Stock, J., and Watson, M. (1989). "Interpreting the evidence on money-output

causality". *Journal of Econometrics,* Jan. 1989, 161-181.
29) Swanson, N. (1998). "Money and Output viewed through rolling window". *Journal of Monetary Economics,* 41, 455-473.
30) Thalassinos, E. and Pociovalisteanu, M. D., (2007), "A Time Series Model for the Romanian Stock Market", European Research Studies Journal, Vol. X, Issue (3-4) pp. 57-72.

Appendix I

ARDL Method: A brief Theoretical Description

The augmented autoregressive distributed lag model ARDL(p, q1, q2,…,qk) is given by

$$\varphi(L,p)y_t = \sum_{i=1}^{k}\beta_i(L,q_i)x_{it} + \delta' w_t + u_t, \qquad (A1)$$

where

$$\varphi(L,p) = 1 - \varphi_1 L - \varphi_2 L^2 - \ldots - \varphi_p L^p, \qquad (A2)$$

$$\beta_i(L,q_i) = \beta_{i0} + \beta_{i1}L + \ldots + \beta_{iq_i}L^{q_i}, \qquad i=1,2,\ldots,k \qquad (A3)$$

w_t is a s×1 vector of deterministic variables (intercept, dummies, trend, exogenous variables with fixed lags) and L is a lag operator defined as $L^r y_r = y_{i-r}$.

At the first step the procedure estimates a total of $(m+1)^{k+1}$ different ARDL models, by means of the OLS method, for all possible values of p(p=0,1,…,m), q(q=0,1,…,m) and i(i=1,…,k). The maximum lag length can be determined by the researcher though the frequency of the data is crucial. The appropriate ARDL specification can be then chosen by means of alternative criteria such as the Akaike Information Criterion (AIC), the Schwarz Bayesian Criterion (SBC), the Hannan and Quinn (HQC), the R^2 and others.

The long run coefficients for the response of y_t to a unit change of x_{it} are estimated by (Pesaran et al*, 1997, pp. 393-394):*

$$\hat{\theta}_i = \frac{\hat{\beta}_i(1,\hat{q}_i)}{\hat{\varphi}(1,\hat{p})} = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + \ldots + \hat{\beta}_{i\hat{q}_i}}{1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \ldots - \hat{\varphi}_{\hat{p}}}, \qquad i=1,2,\ldots,k \qquad (A4)$$

where $\hat{p}$ and $\hat{q}_i$, i=1,2,…,k are the selected values of p and qi. The long run coefficients associated with the deterministic and exogenous variables with fixed lags are estimated by

$$\hat{\psi} = \frac{\hat{\delta}(\hat{p},\hat{q}_1,\hat{q}_2,\ldots,\hat{q}_k)}{1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \ldots - \hat{\varphi}_{\hat{p}}}, \qquad (A5)$$

where $\hat{\delta}(\hat{p},\hat{q}_1,\hat{q}_2,\ldots,\hat{q}_k)$ denotes the OLS estimates of δ in (A1) for the selected ARDL specification.

The ECM representation associated with the implied ARDL model can be obtained by writing (A1) in terms of the lagged levels and the first differences of y_t, x_{1t},….,x_{st} and w_t.

Based on (A4) and (A5) the error correction term EC_t is defined by

$$EC_t = y_t - \sum_{i=1}^{k}\hat{\theta}_i x_{it} - \hat{\psi}' w_t. \qquad (A6)$$

Appendix II

TABLE 1: Unit-Root Tests for the Variables in Levels

Variable	k	with intercept no trend	k	with intercept and linear trend
LY	3	1.539	2	-0,227
LXP	1	-2.606	1	-1.164
LIG	2	0.124	3	-0.668
LP	2	-2.283	3	0.414
EXIR	2	-0.239	2	-0.915

95% critical value for the augmented Dickey-Fuller statistic with intercept but not a trend = -2.949
95% critical value for the augmented Dickey-Fuller statistic with intercept and a linear trend = -3.546

TABLE 2: Unit-Root Tests for the Variables in First Differences

Variable	k	with intercept no trend	k	with intercept and linear trend
DLY	1	-3.535	1	-3.451
DLXP	1	-3.973	1	-5.795
DLIG	2	-3.676	2	-3.626
DLP	1	-3.594	1	-4.929
DEXIR	1	-4.805	1	-5.816

95% critical value for the augmented Dickey-Fuller statistic with intercept but not a trend = -2.952
95% critical value for the augmented Dickey-Fuller statistic with intercept and a linear trend = -3.551

TABLE 3: Testing the Existence of a Long Run Relationship

Dependent Variable	F-statistic	Intercept	Trend	Bounds Testing (at 90%)	
DLY	5.086	yes	no	lower: 4.042	upper: 4.778

TABLE 4

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            Autoregressive Distributed Lag Estimates
      ARDL(3,0,0,1,0) selected based on Schwarz Bayesian Criterion
*******************************************************************************
Dependent variable is LY
29 observations used for estimation from 1976 to 2004
*******************************************************************************
Regressor          Coefficient      Standard Error       T-Ratio[Prob]
LY(-1)              .34907           .17946              1.9451[.066]
LY(-2)             -.20862           .14648             -1.4243[.170]
LY(-3)              .32793           .098266             3.3372[.003]
LXP                 .022086          .017910             1.2332[.232]
LIG                 .18770           .036471             5.1464[.000]
EXIR                .0018574         .9325E-3            1.9918[.060]
EXIR(-1)           -.0043479         .9731E-3           -4.4679[.000]
LP                  .026085          .015019             1.7368[.098]
C                   11.1150          1.9790              5.6165[.000]
*******************************************************************************
R-Squared                  .99623   R-Bar-Squared                .99473
S.E. of Regression         .011613  F-stat.   F(  8,  20)  661.1310[.000]
Mean of Dependent Variable  25.0799  S.D. of Dependent Variable     .15991
Residual Sum of Squares    .0026973  Equation Log-likelihood       93.4512
Akaike Info. Criterion      84.4512  Schwarz Bayesian Criterion    78.2983
DW-statistic               2.5227
*******************************************************************************
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        Diagnostic Tests
*******************************************************************************
*   Test Statistics  *       LM Version        *        F Version         *
*******************************************************************************
*                    *                         *                          *
* A:Serial Correlation*CHSQ(   1)=   3.9257[.048]*F(   1,  19)=   2.9747[.101]*
*                    *                         *                          *
* B:Functional Form   *CHSQ(   1)=   .65456[.418]*F(   1,  19)=   .43875[.516]*
*                    *                         *                          *
* C:Normality         *CHSQ(   2)=   1.9903[.370]*      Not applicable       *
*                    *                         *                          *
* D:Heteroscedasticity*CHSQ(   1)=   .10805[.742]*F(   1,  27)=   .10097[.753]*
*******************************************************************************
  A:Lagrange multiplier test of residual serial correlation
  B:Ramsey's RESET test using the square of the fitted values
  C:Based on a test of skewness and kurtosis of residuals
  D:Based on the regression of squared residuals on squared fitted values
```

Table 5

Estimated Long Run Coefficients using the ARDL Approach
ARDL(3,0,0,1,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is LY
29 observations used for estimation from 1976 to 2004

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LXP	.041545	.029101	1.4276[.169]
LIG	.35307	.046966	7.5175[.000]
EXIR	-.0046849	.0017795	-2.6326[.016]
LP	.049066	.031732	1.5463[.138]
C	20.9078	.63622	32.8628[.000]

****

Table 6

Error Correction Representation for the Selected ARDL Model
ARDL(3,0,0,1,0) selected based on Schwarz Bayesian Criterion

****

Dependent variable is dLY
29 observations used for estimation from 1976 to 2004

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dLY1	-.11931	.12654	-.94287[.356]
dLY2	-.32793	.098266	-3.3372[.003]
dLXP	.022086	.017910	1.2332[.231]
dLIG	.18770	.036471	5.1464[.000]
dEXIR	.0018574	.9325E-3	1.9918[.060]
dLP	.026085	.015019	1.7368[.097]
dC	11.1150	1.9790	5.6165[.000]
ecm(-1)	-.53162	.099409	-5.3478[.000]

****

ecm = LY -.041545*LXP -.35307*LIG + .0046849*EXIR -.049066*LP -20.9078*C

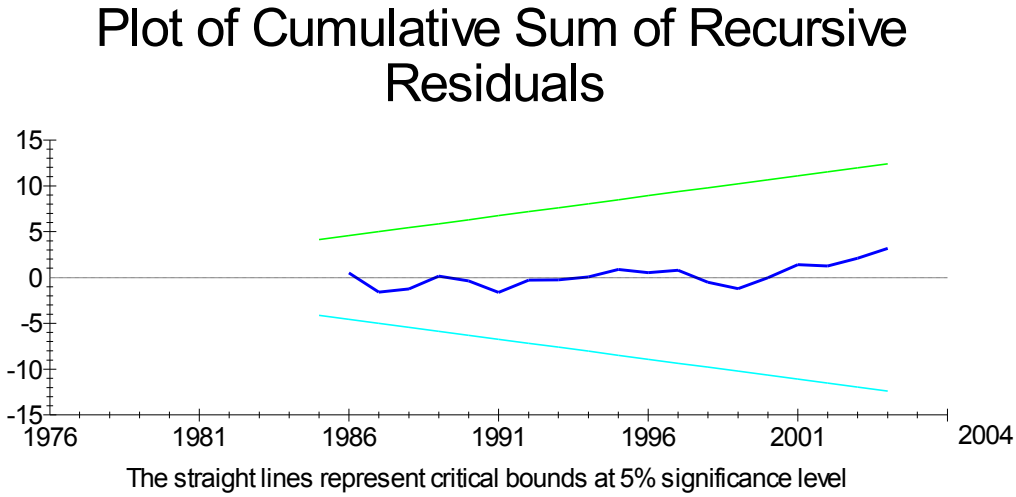
****

R-Squared .83326 R-Bar-Squared .76657
S.E. of Regression .011613 F-stat. F(7, 21) 14.2787[.000]
Mean of Dependent Variable .023366 S.D. of Dependent Variable .024037
Residual Sum of Squares .0026973 Equation Log-likelihood 93.4512
Akaike Info. Criterion 84.4512 Schwarz Bayesian Criterion 78.2983
DW-statistic 2.5227

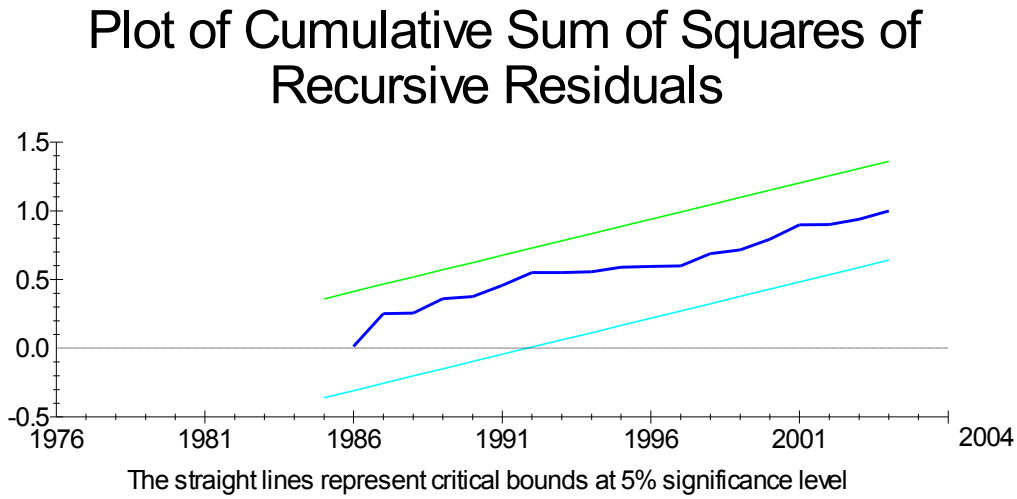
****

R-Squared and R-Bar-Squared measures refer to the dependent variable
dLY and in cases where the error correction model is highly
restricted, these measures could become negative.

Graph 1



Graph 2



Appendix III

Figure 1: Income Growth

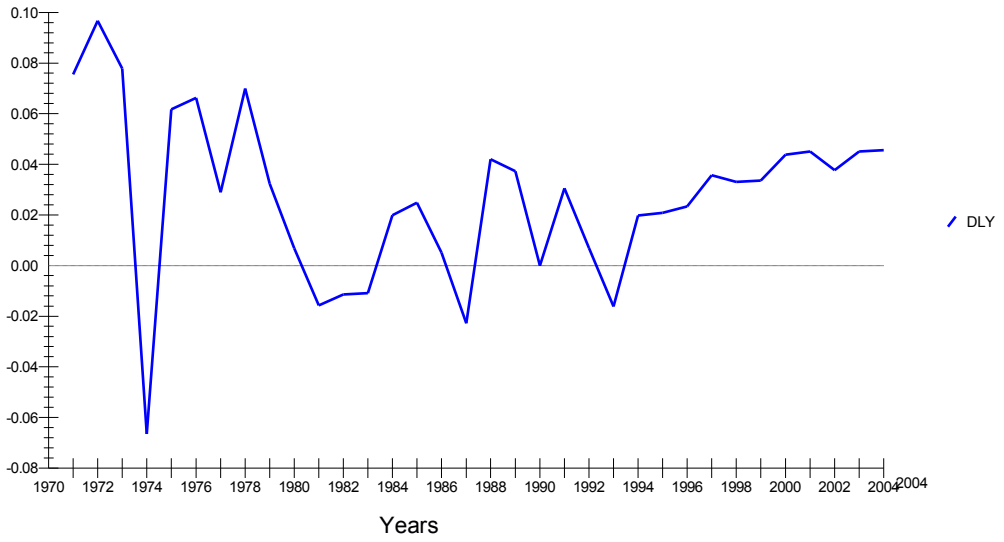


Figure 2: Interest rate

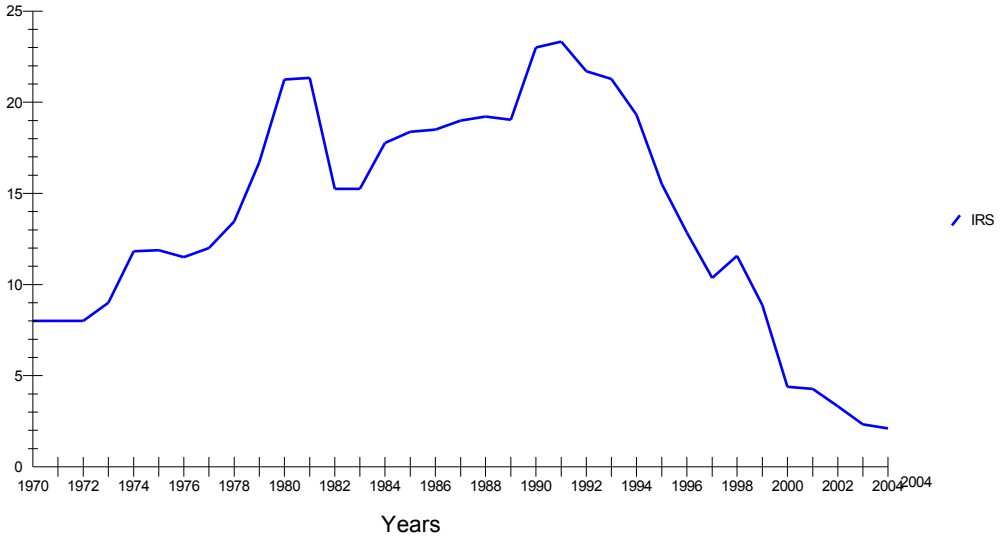


Figure 3: Inflation Rate

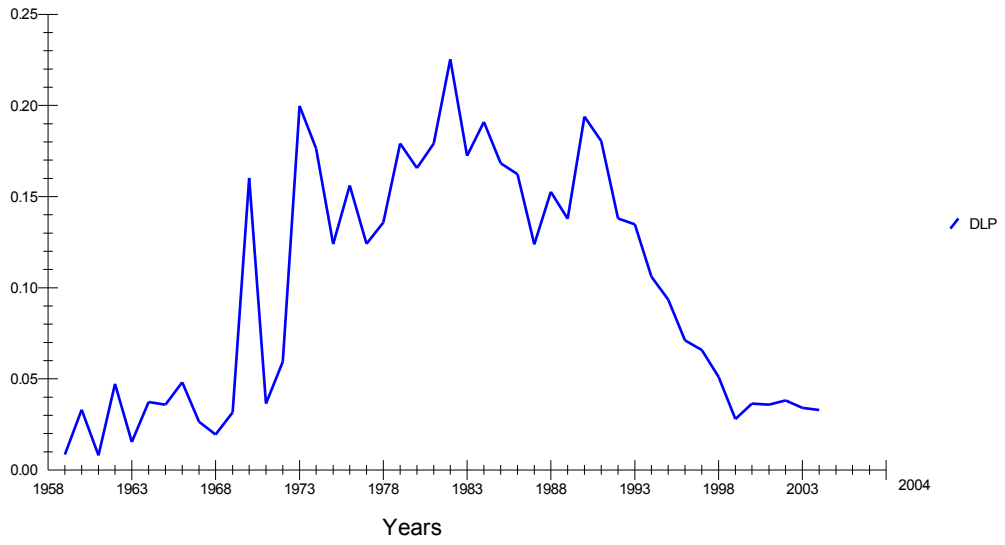


Figure 4: Growth of Government Investment

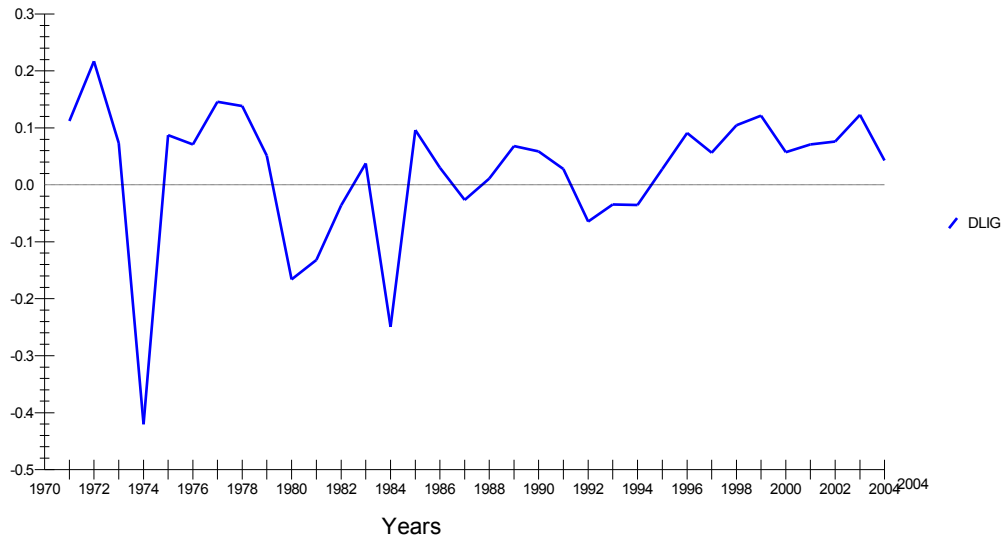
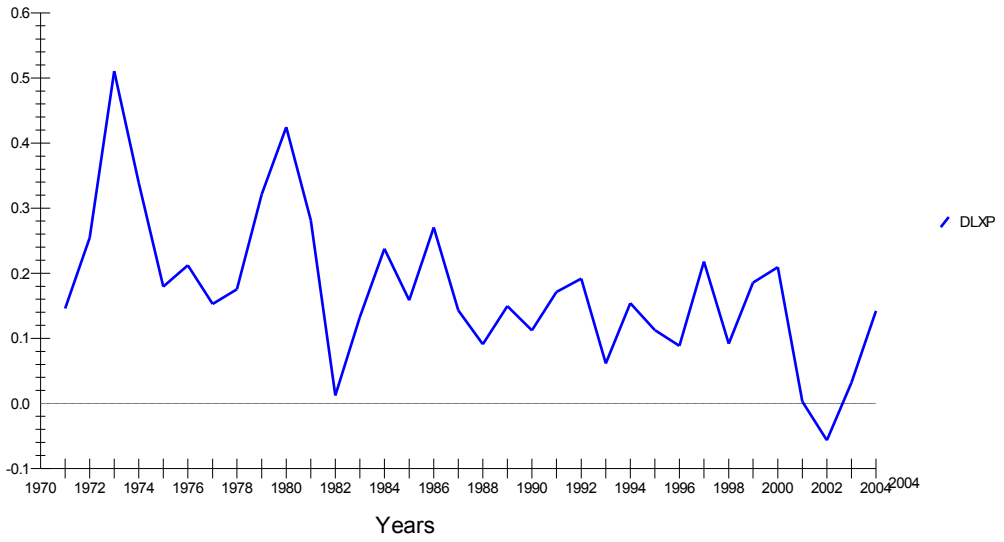



Figure 5: Growth of Exports